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→ FRINGE 2015 WORKSHOP

Advances in the Science and Applications of SAR Interferometry
and Sentinel-1 InSAR Workshop

Ice Velocity Mapping Using TOPS SAR Data and Offset Tracking

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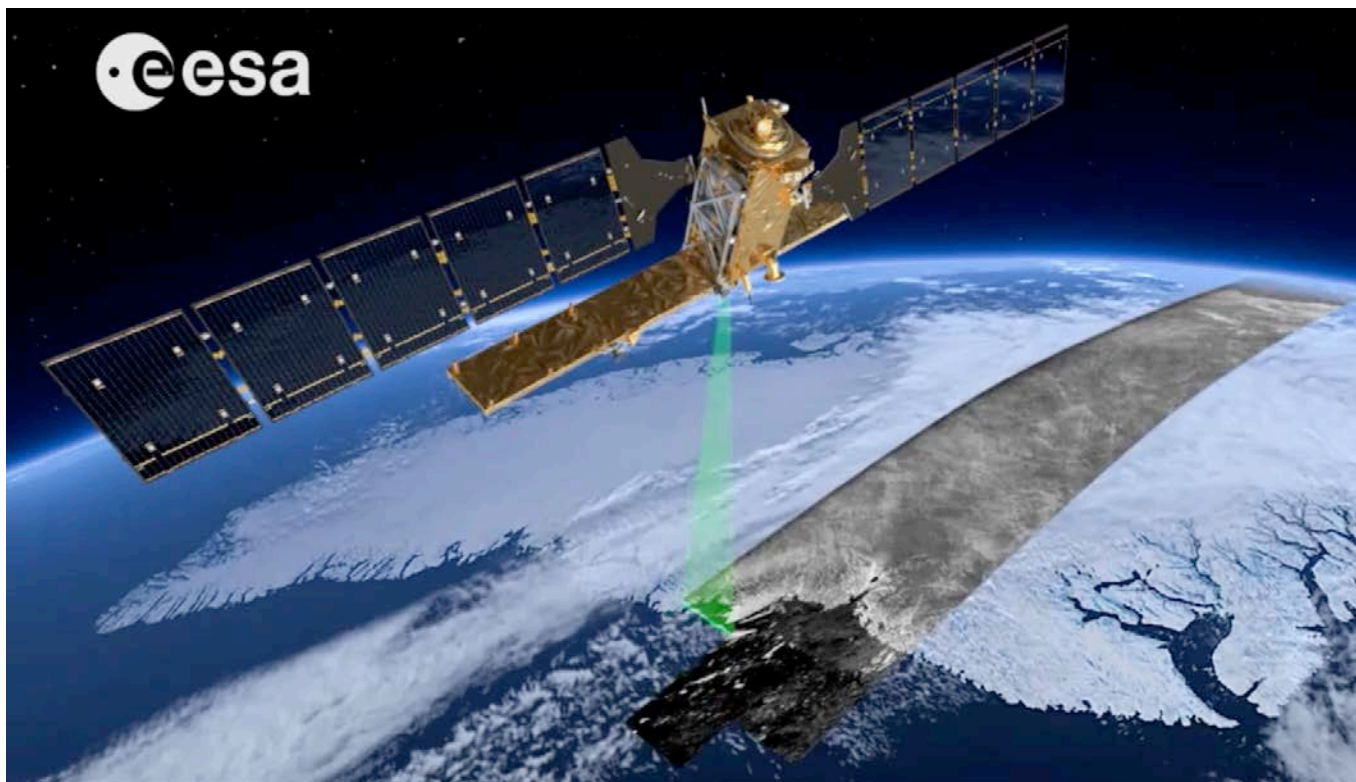
- Introduction
- Problem (TOPS + large displacements)
- Method
- Results
- Conclusions

Offset tracking

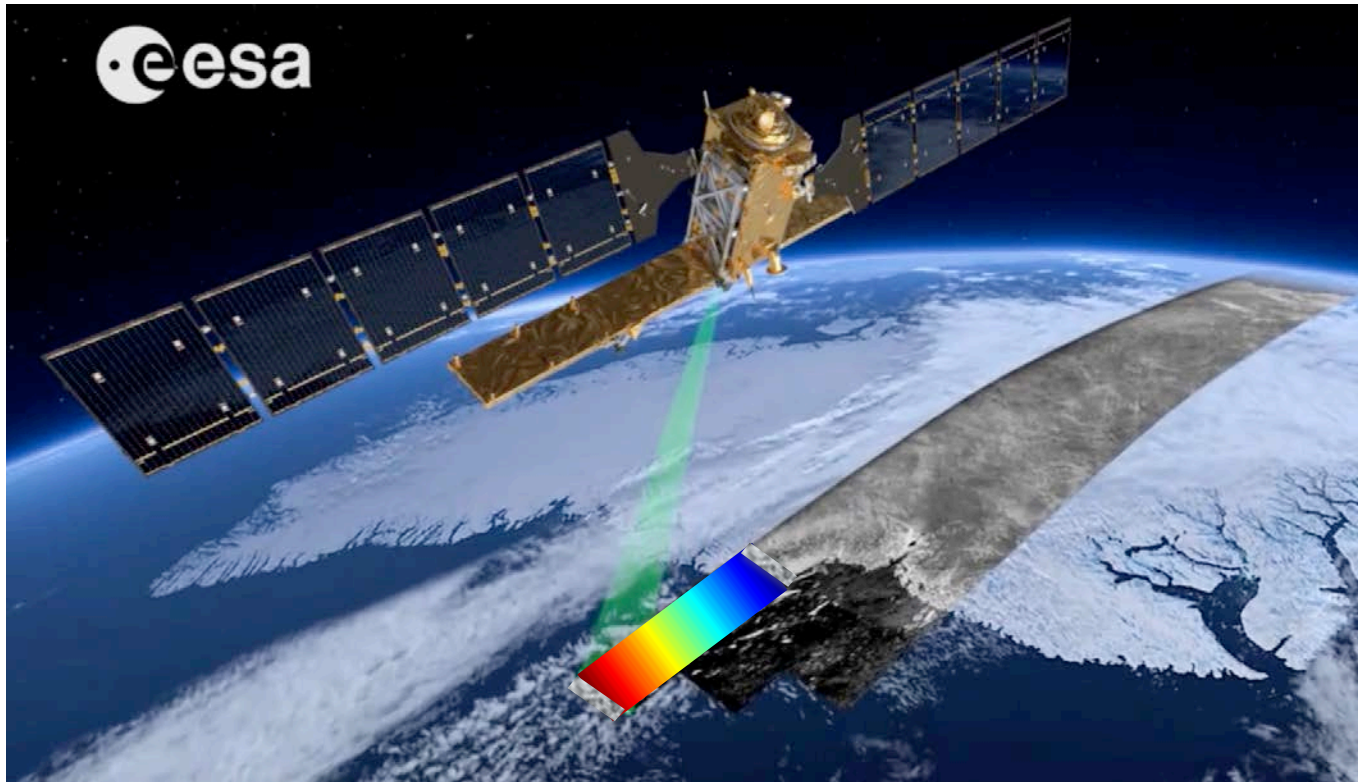


	Feature tracking	Speckle tracking
Method	Cross-correlation	Cross-correlation
Data type	Detected	Detected or complex
Features	Required	Not required
Coherence	Not required	Required
Patch size	Larger	Smaller
Accuracy	Coarser	Finer

TOPS



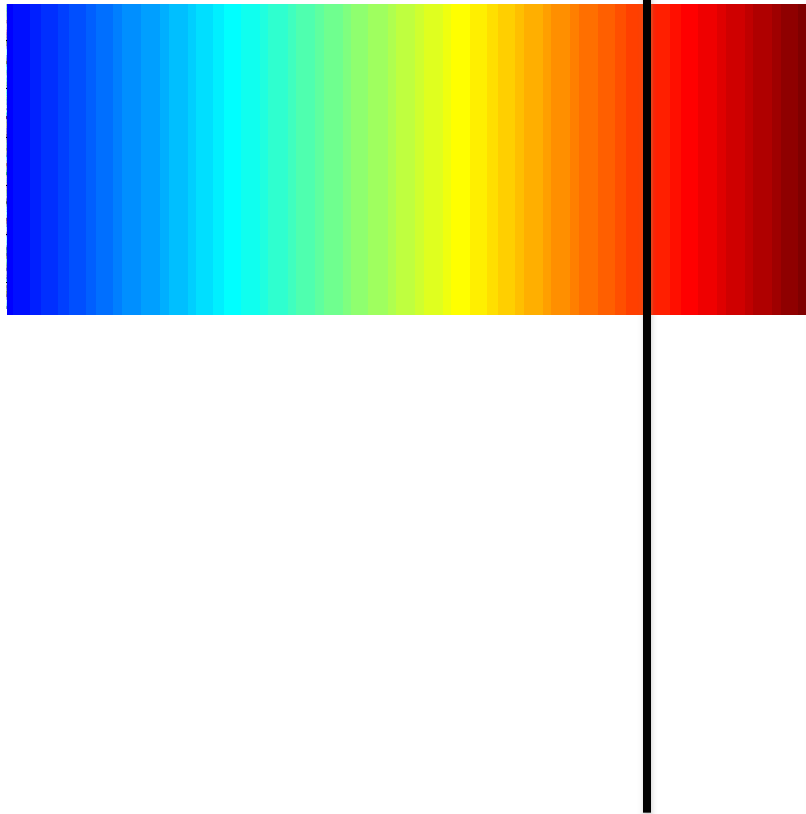
TOPS



Offset tracking with TOPS data



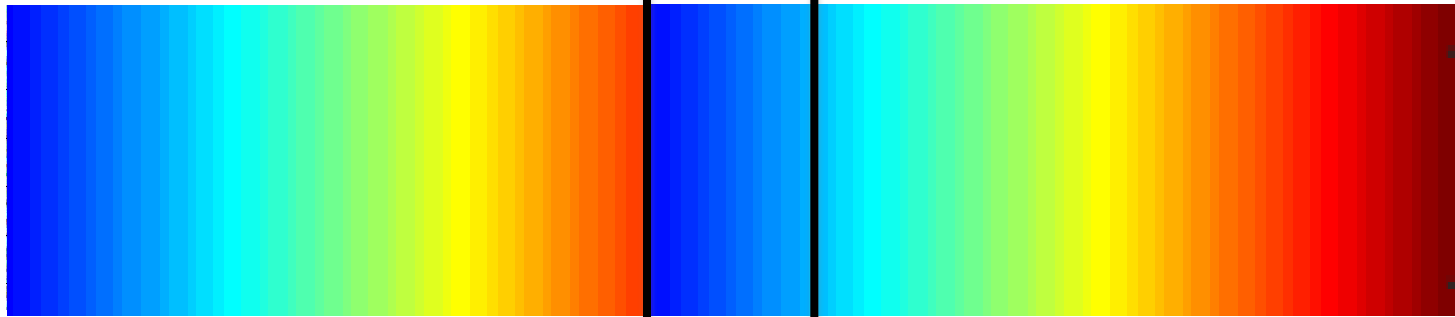
1st acquisition



Offset tracking with TOPS data



1st acquisition



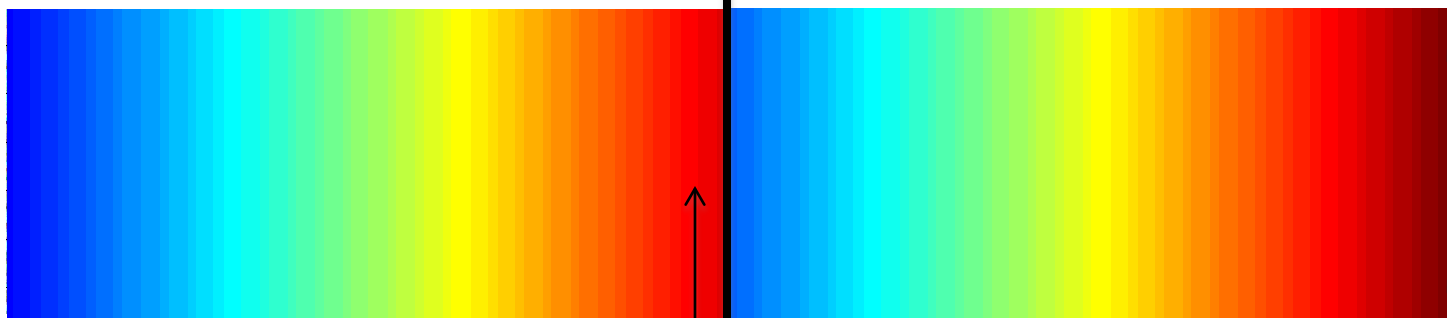
IW SLC product:

- Spatial overlap
- No spectral overlap => speckle pattern differs

Offset tracking with TOPS data

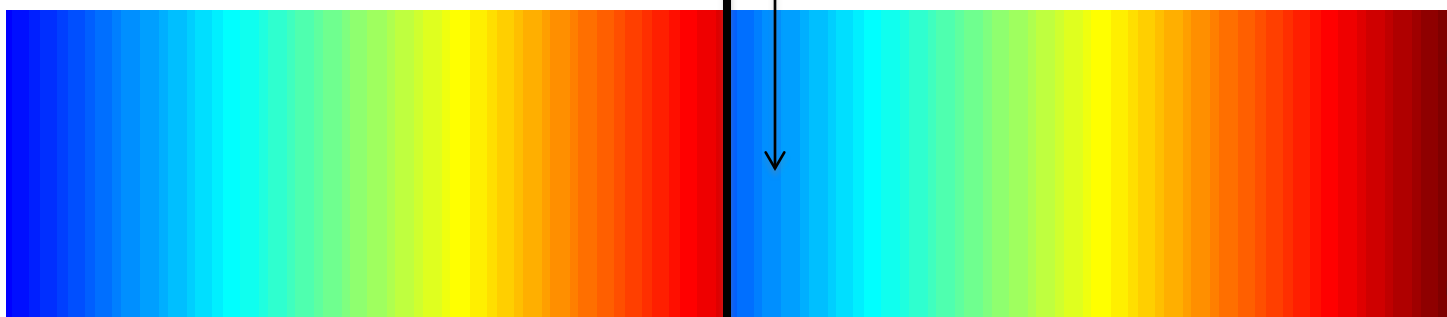


1st acquisition



GRD product: features are preserved when crossing the burst seam

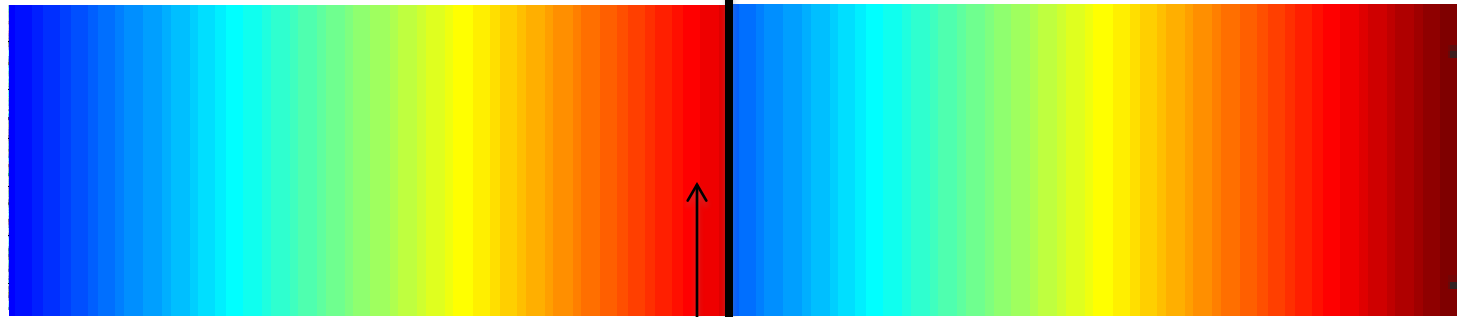
2nd acquisition



Offset tracking with TOPS data

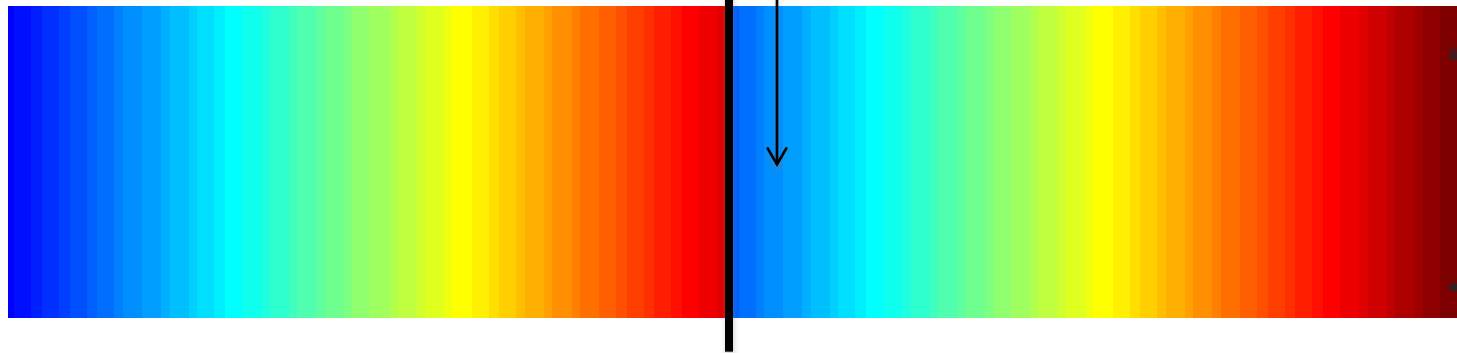


1st acquisition



GRD product: Speckle changes when crossing the burst seam => gap

2nd acquisition



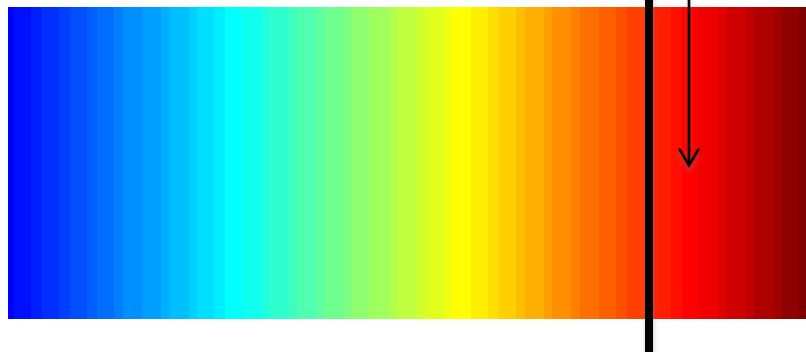
Offset tracking with TOPS data



1st acquisition



2nd acquisition



SLC product: gaps can also be avoided with speckle tracking if
ice displacement + patch size < overlap

Offset tracking with TOPS data



1st acquisition



2nd acquisition

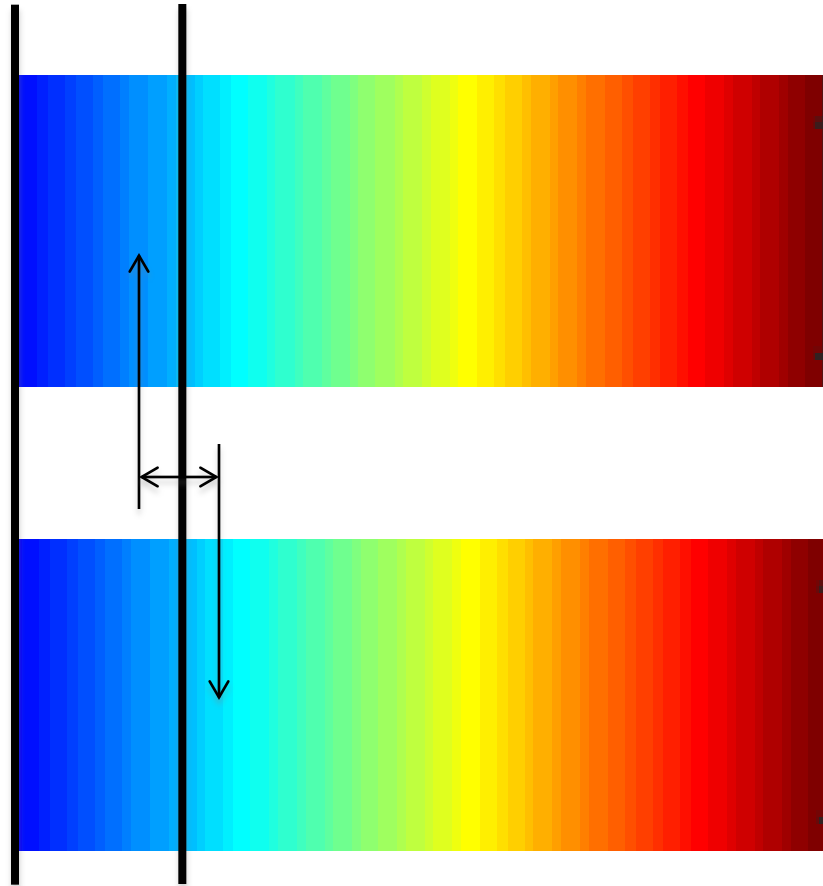


SLC product: gaps can also be avoided with speckle tracking if
ice displacement + patch size < overlap

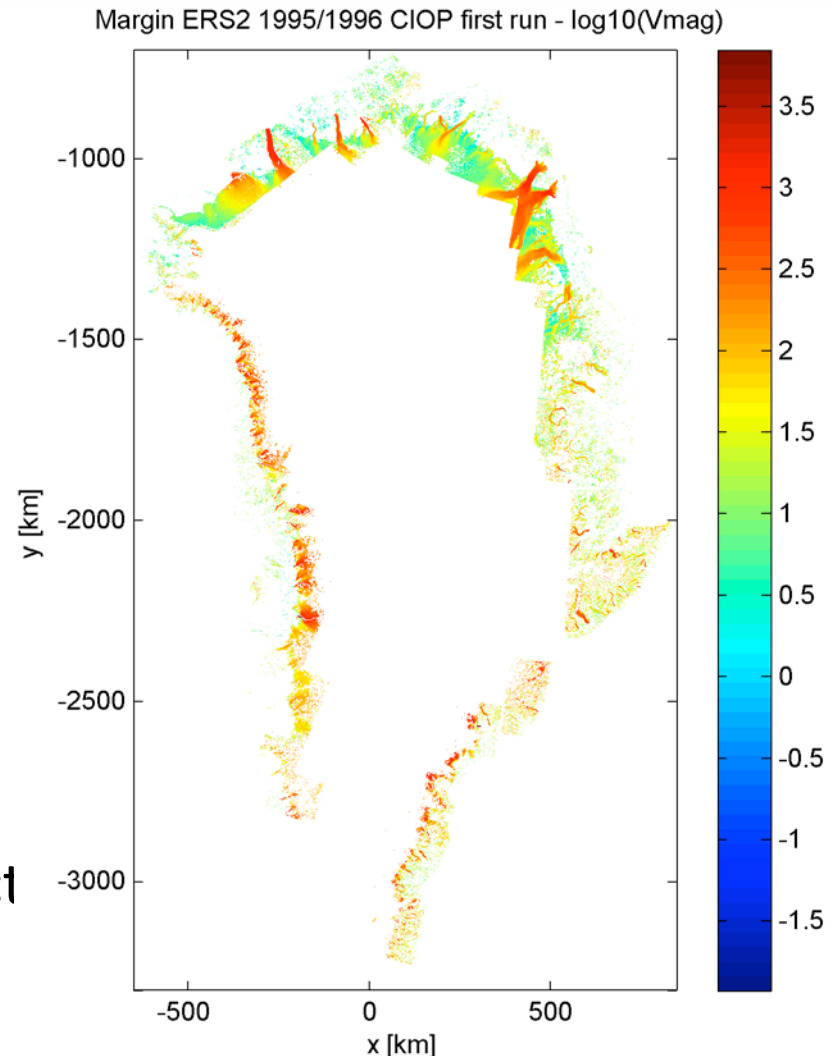
Offset tracking with TOPS data



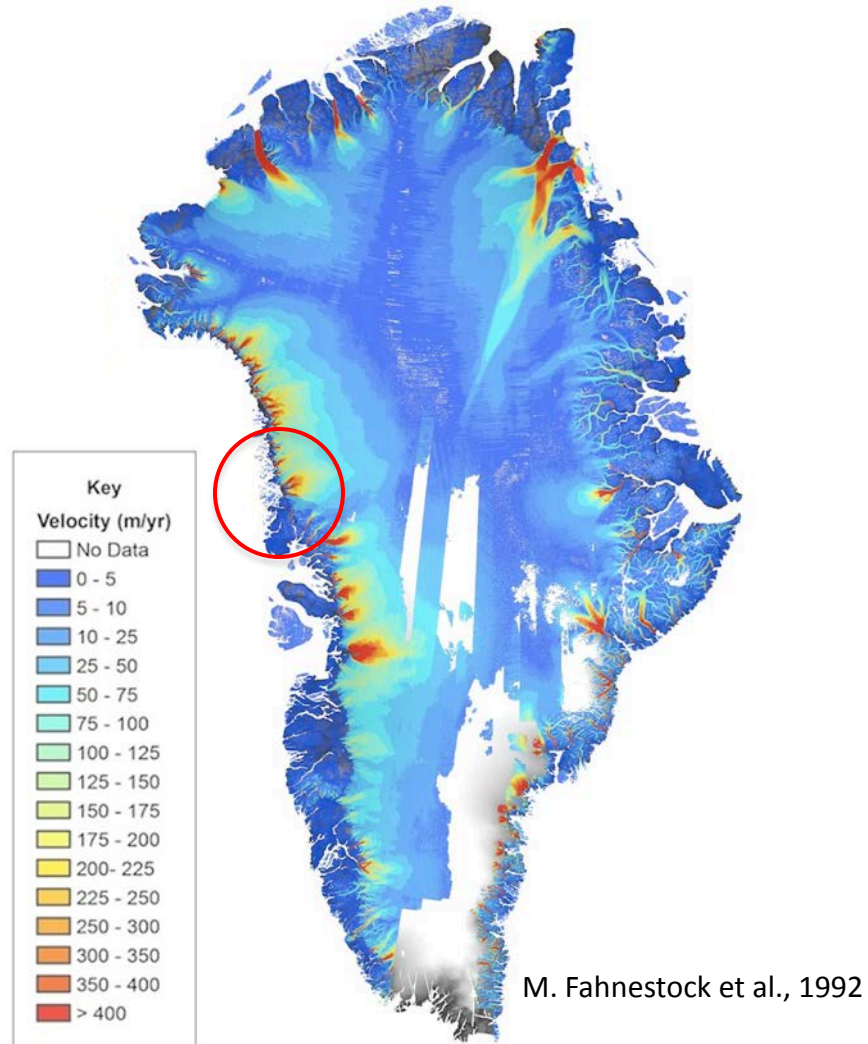
SLC product: gaps can also be avoided with speckle tracking if
ice displacement + patch size < overlap



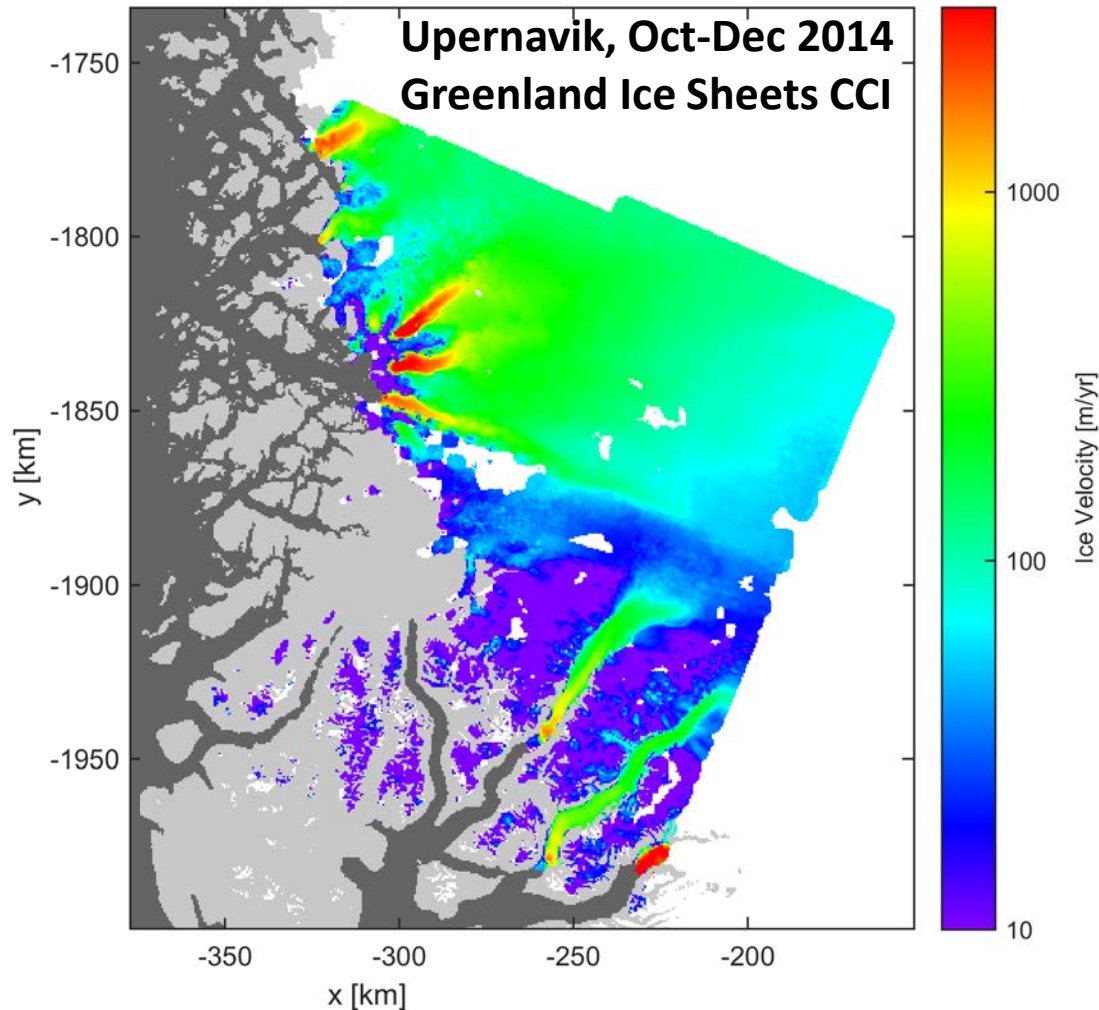
- Intended for DInSAR
(DEM elimination &
Double Difference)
- Upgraded for ESA's
Climate Change Initiative
(GrIS CCI, AIS CCI):
 - Offset Tracking
 - Bulk processing
(cloud computing)
 - Sentinel-1 IW SLC product



Upernavik glaciers

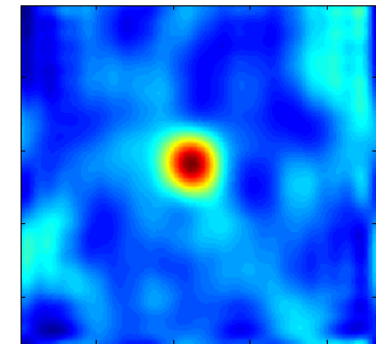


Ice velocity (Sentinel-1 IW SLC)



Normalized cross-correlation:

$$NCC(i, j) = \frac{\sum_{k, l} (s(i+k, j+l) - \mu_s)(r(k, l) - \mu_r)}{\sqrt{\sum_{k, l} |s(i+k, j+l) - \mu_s|^2 \sum_{k, l} |r(k, l) - \mu_r|^2}}$$



Figures of merit:

- $\max(NCC)$
- 'signal-to-noise ratio' (SNR)

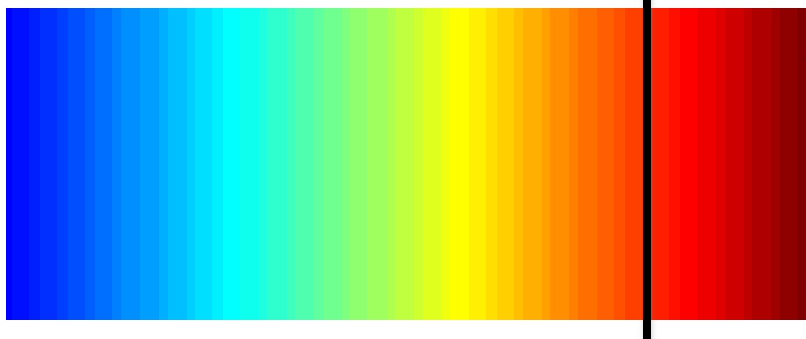
Approach



1st acquisition

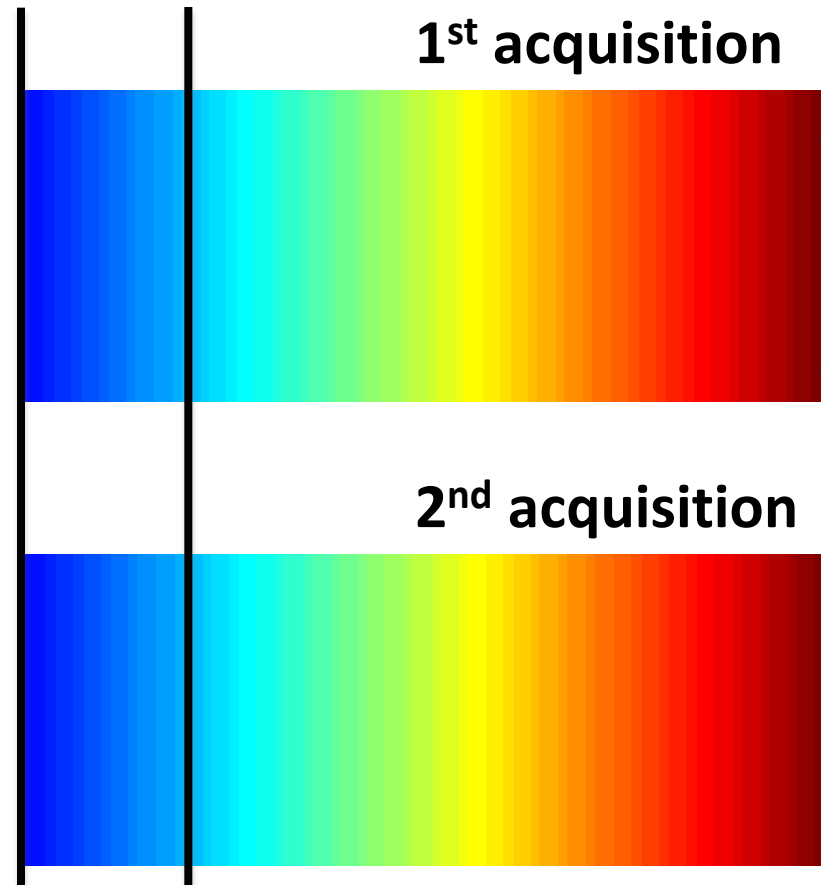


2nd acquisition

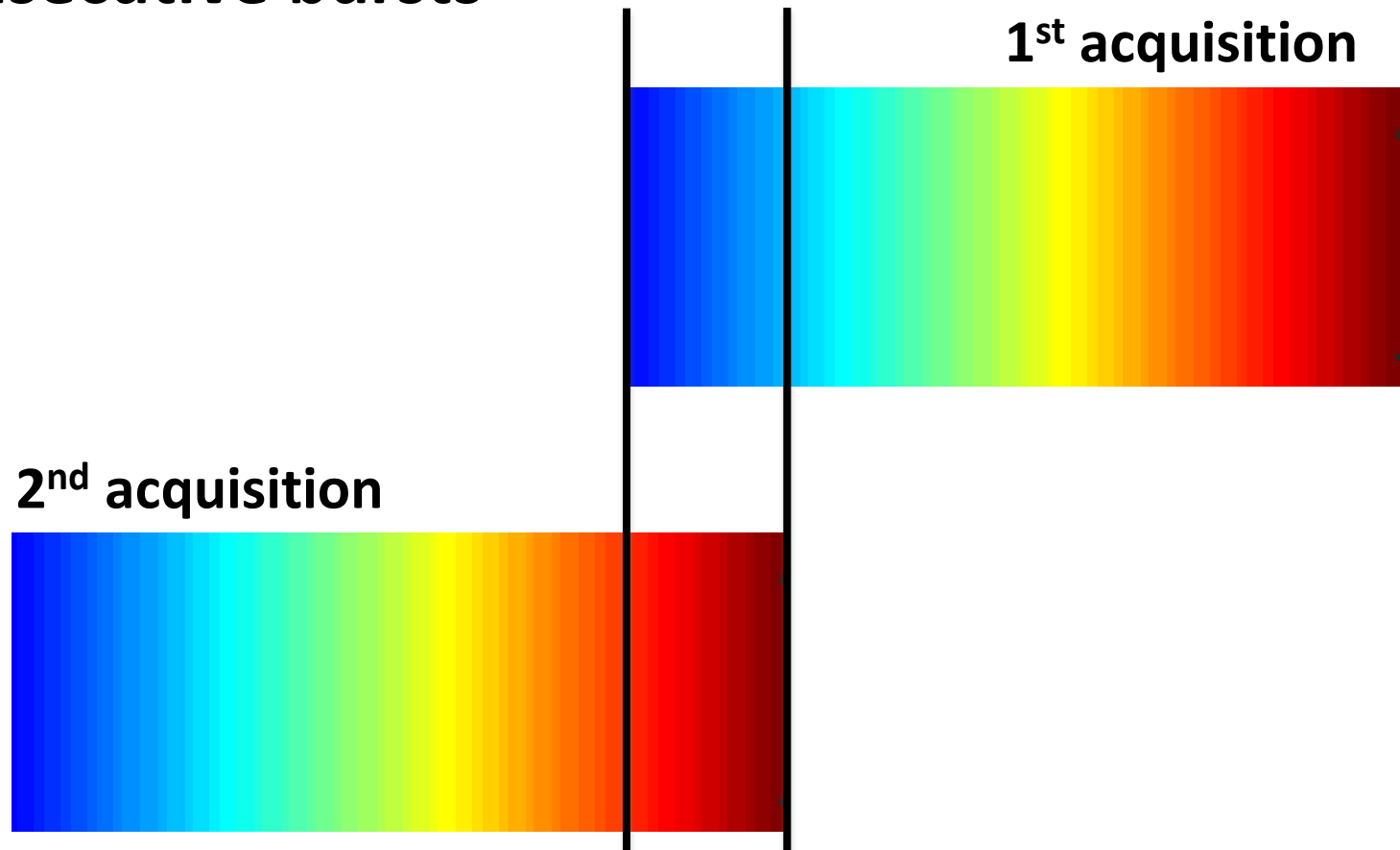


Corresponding bursts
(exploited by IPP)

Corresponding bursts (exploited by IPP)



Consecutive bursts



Approach



1st acquisition

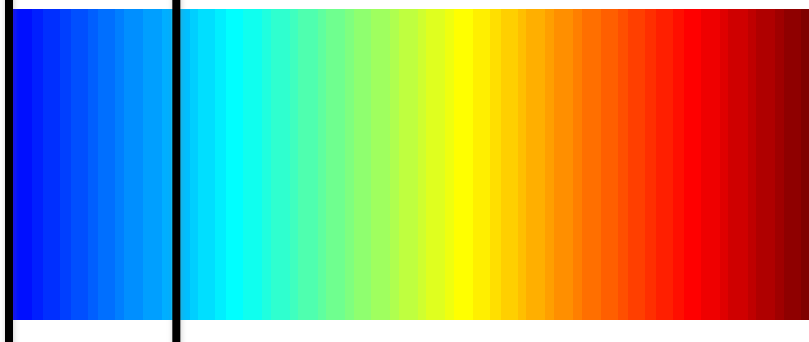


Patch: 256 x 64
(ra x az pixels)

Increment: 40, 10
(ra, az pixels)

Consecutive bursts
(analysed in this study)

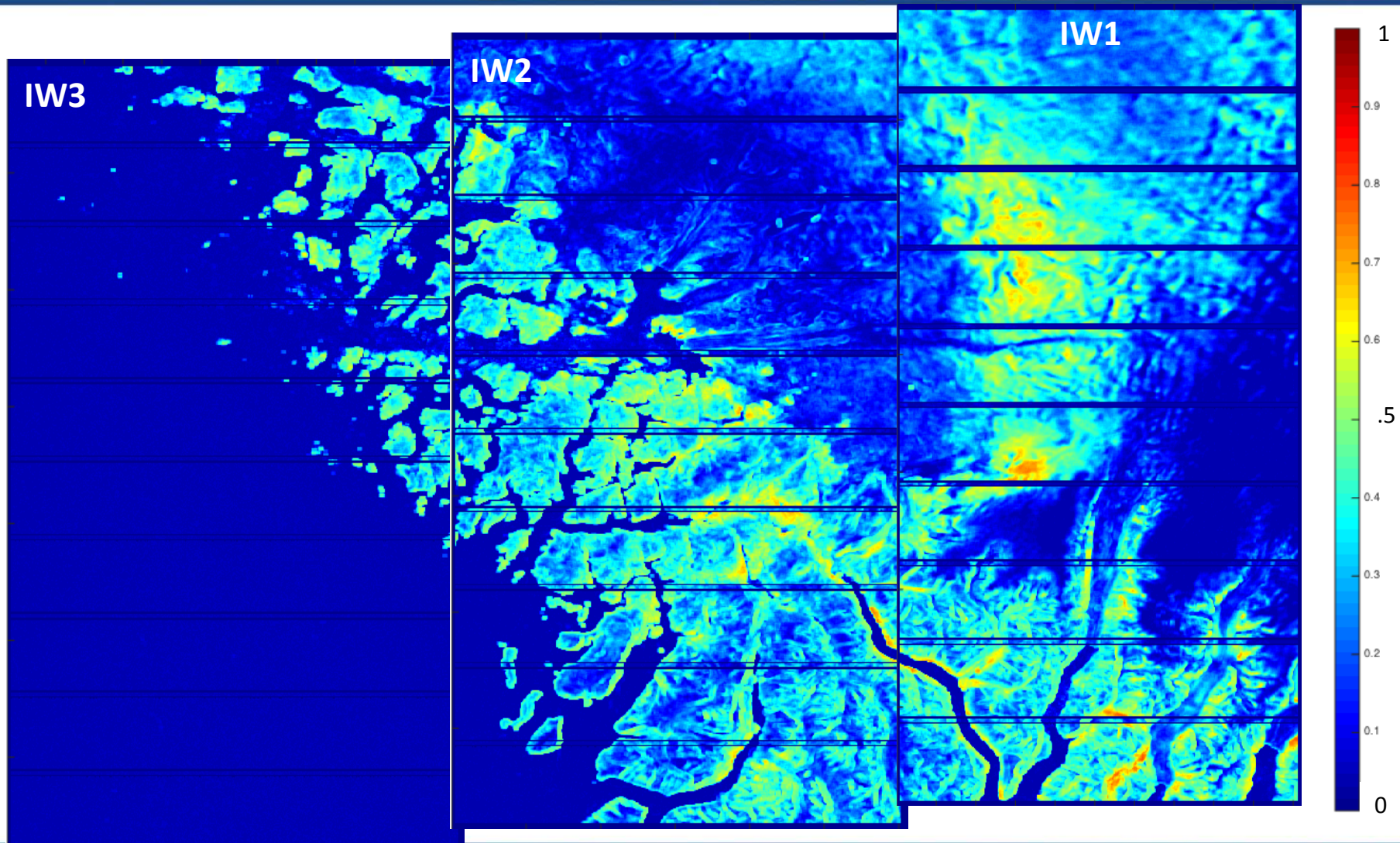
2nd acquisition



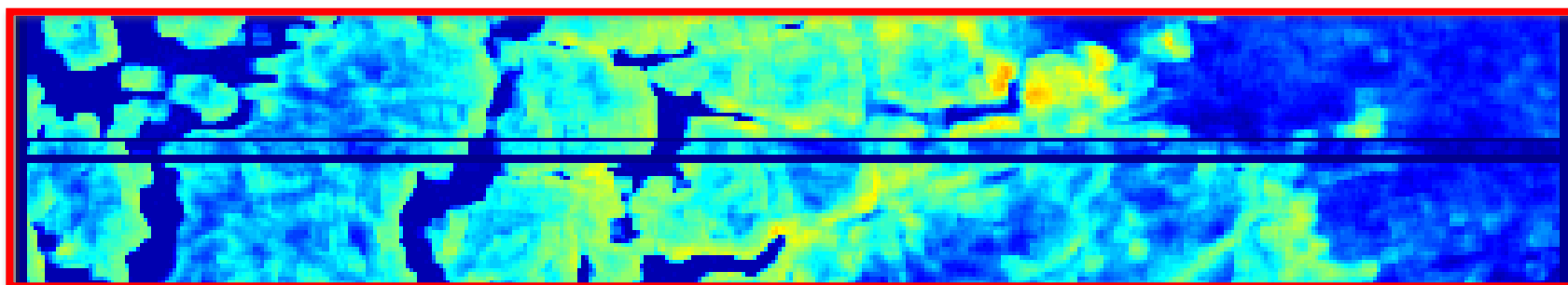
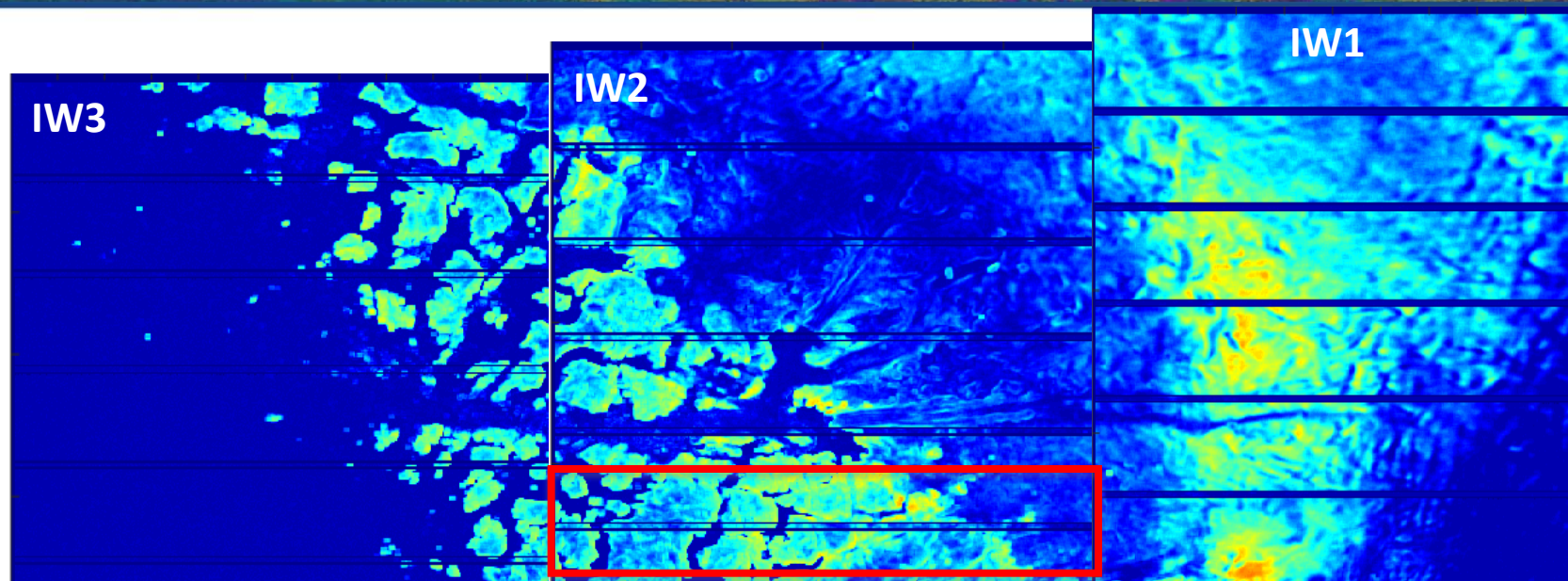
Questions:

- In the overlap area four multi-temporal cross-correlations can be computed. Which ones are useful?
- Where do consecutive (multi-temporal) bursts decorrelate?
- Does the GRD product lead to more velocity gaps?
- Do the dual squint angles within the burst overlap provide valuable glaciological information?

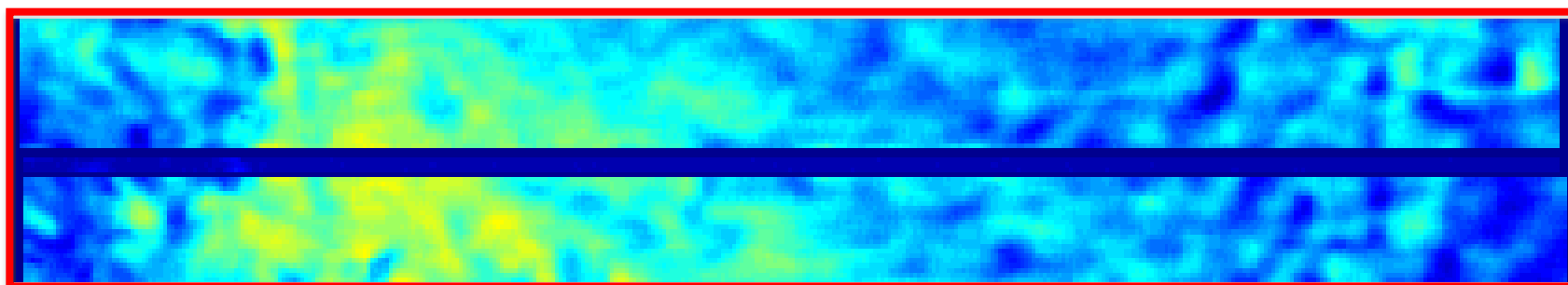
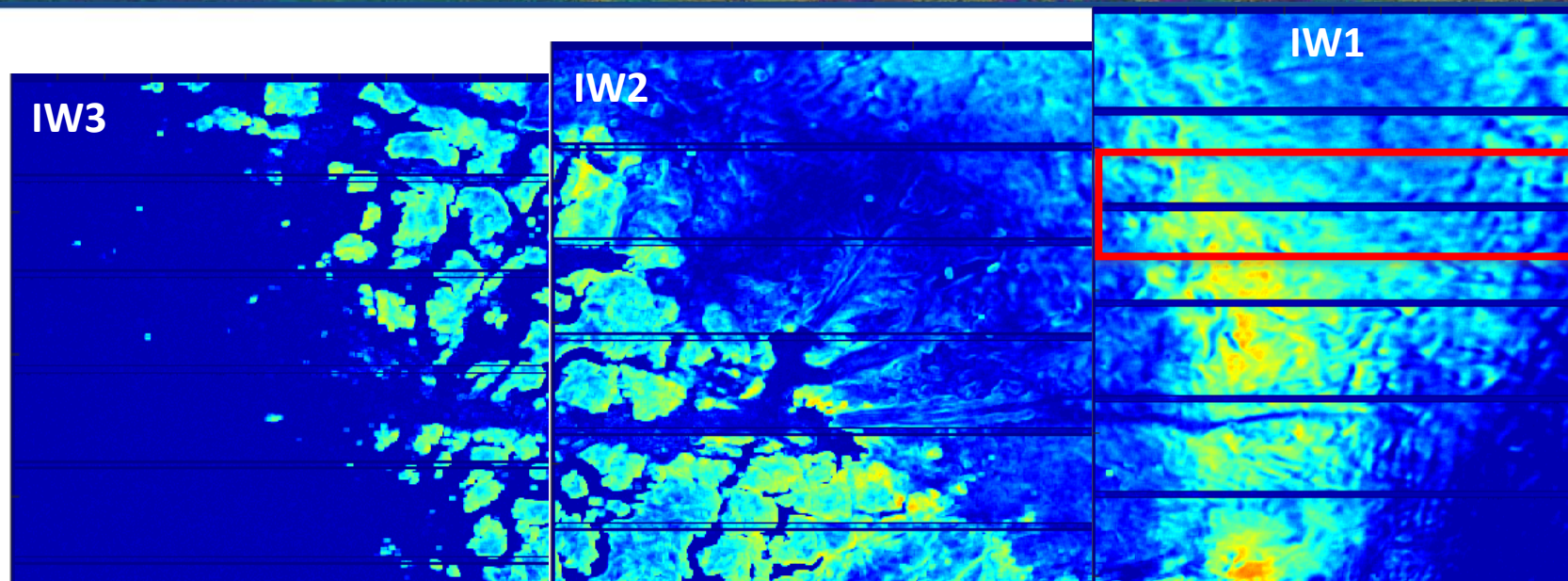
Results: NCC



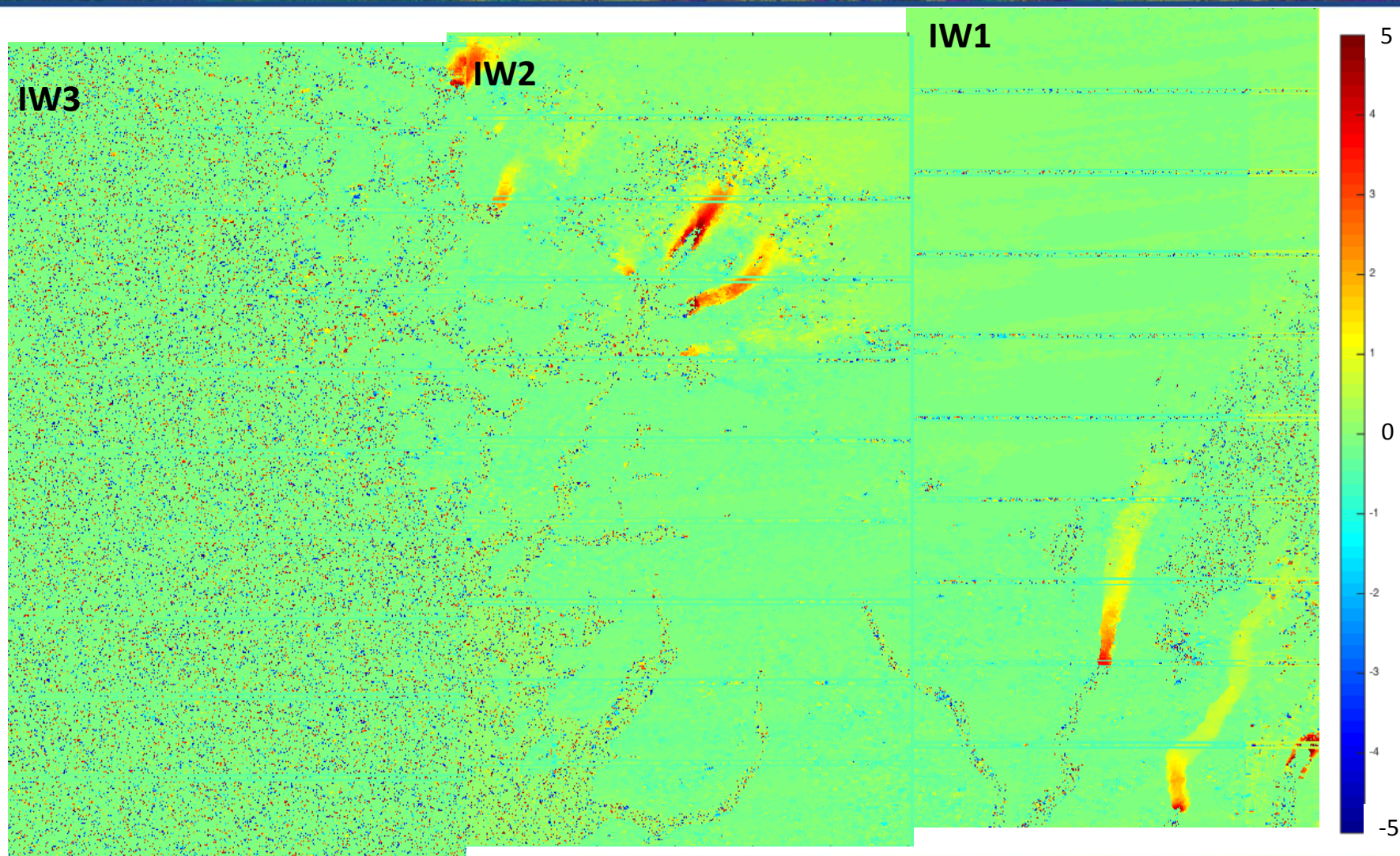
Results: NCC



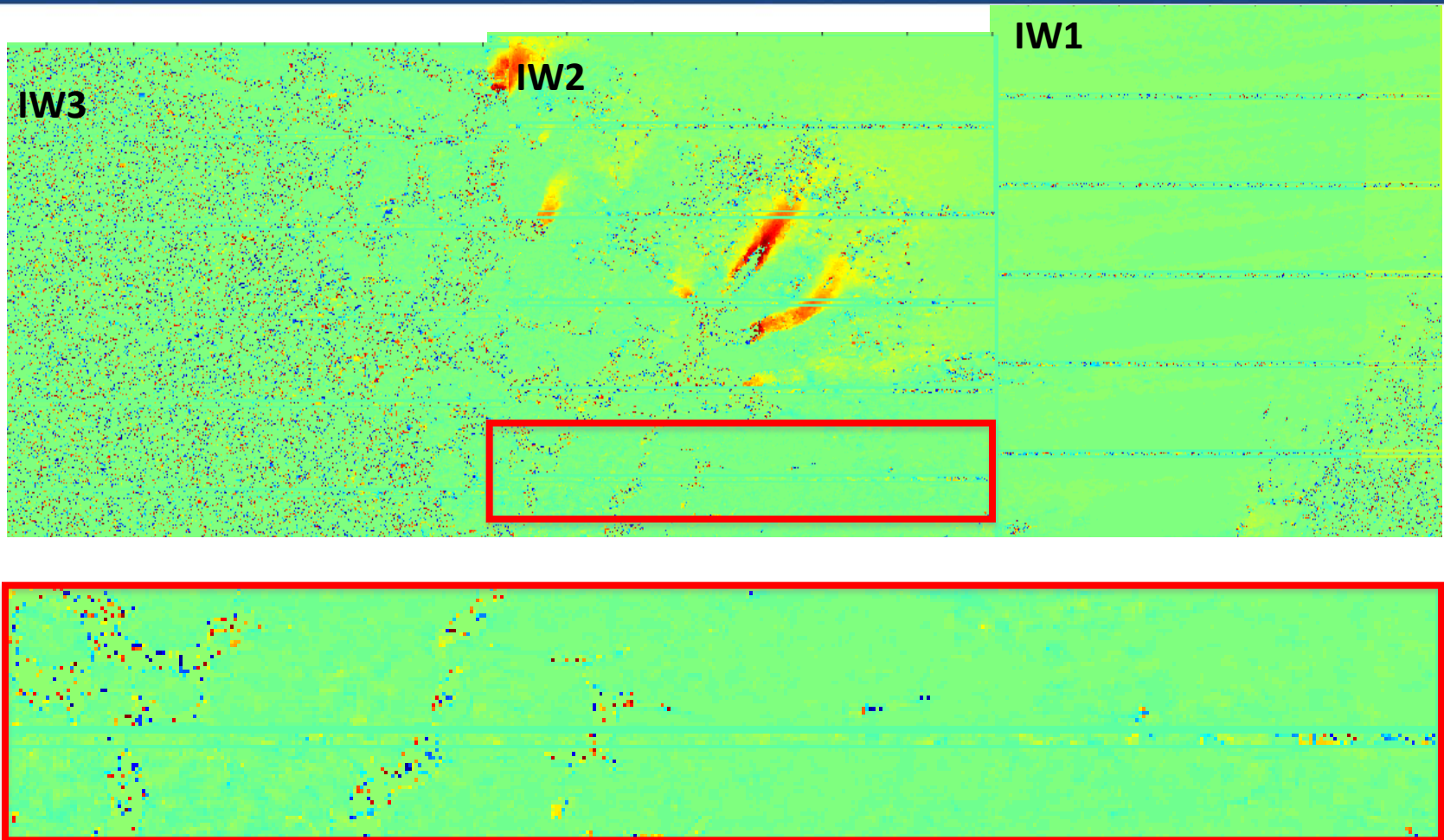
Results: NCC



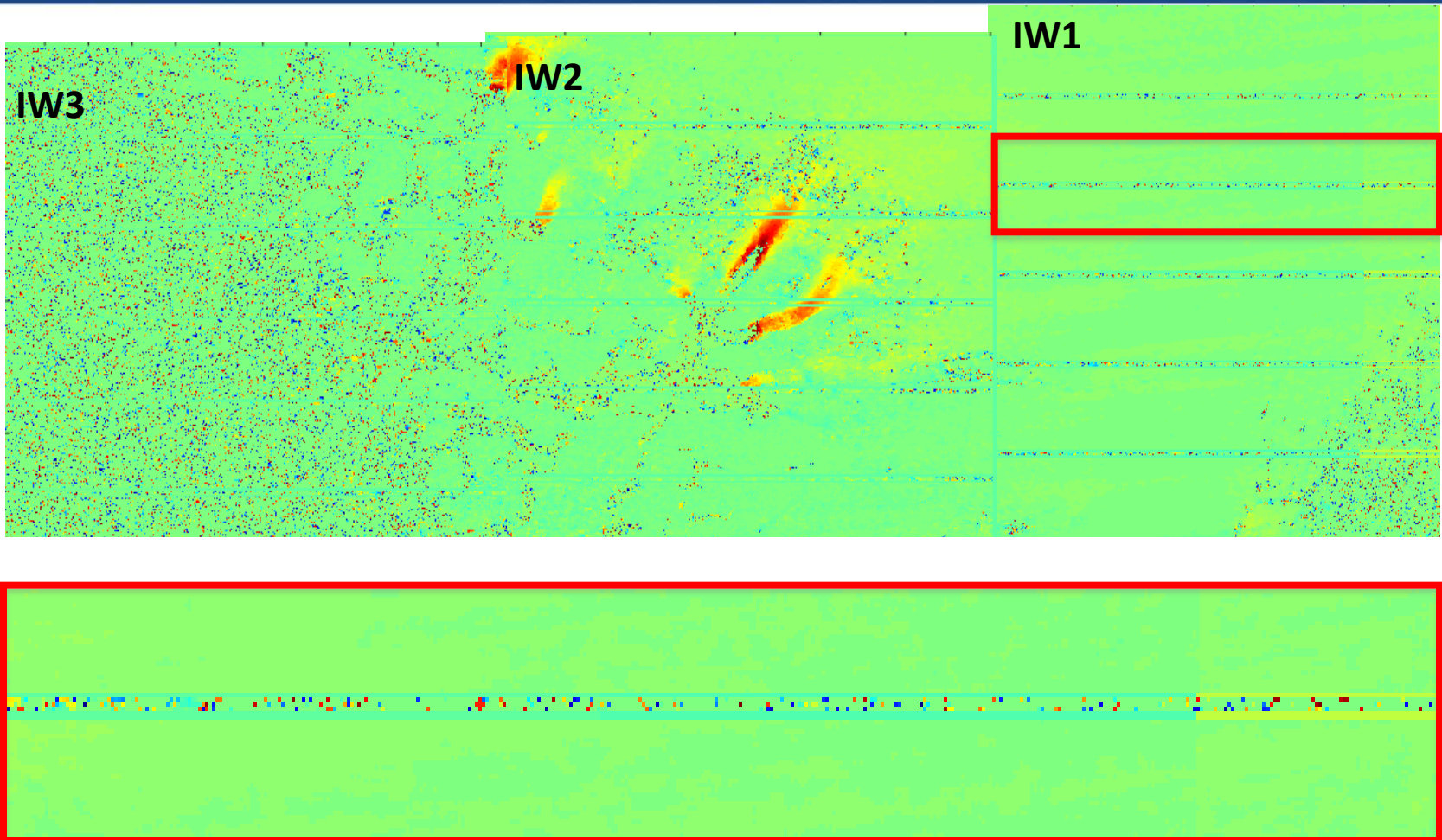
Results: azimuth displacement



Results: azimuth displacement



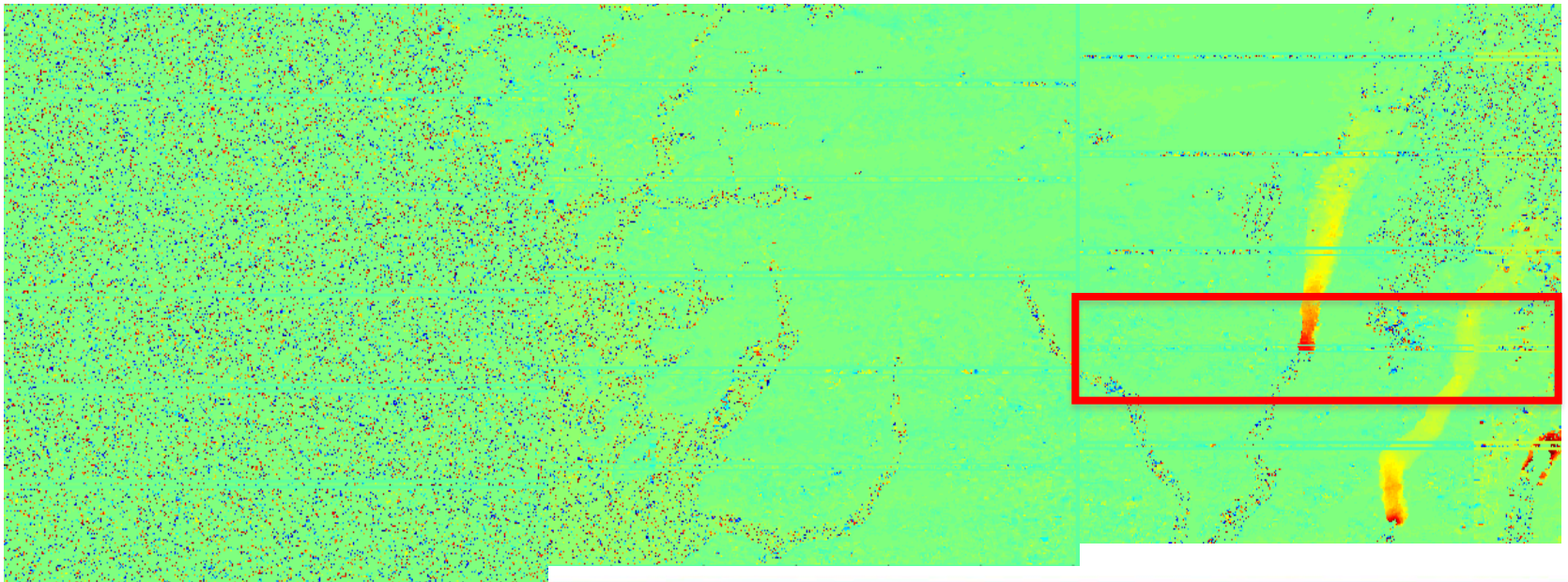
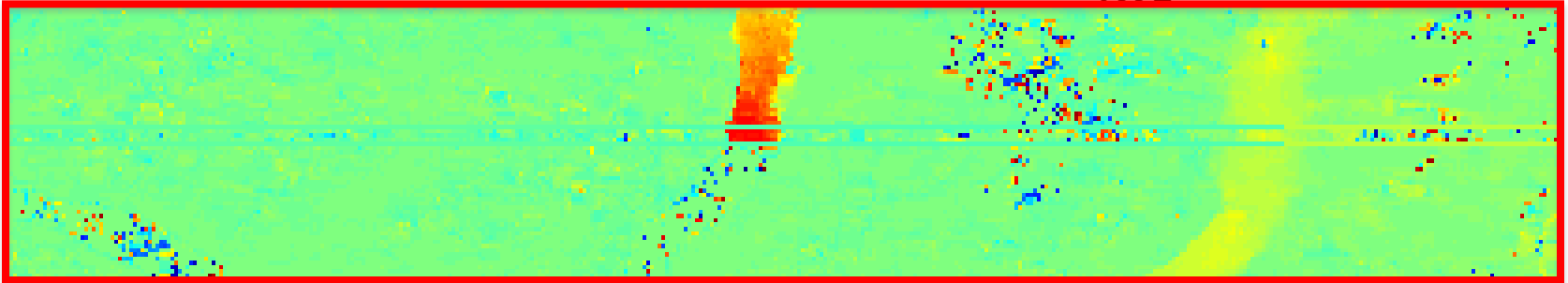
Results: azimuth displacement



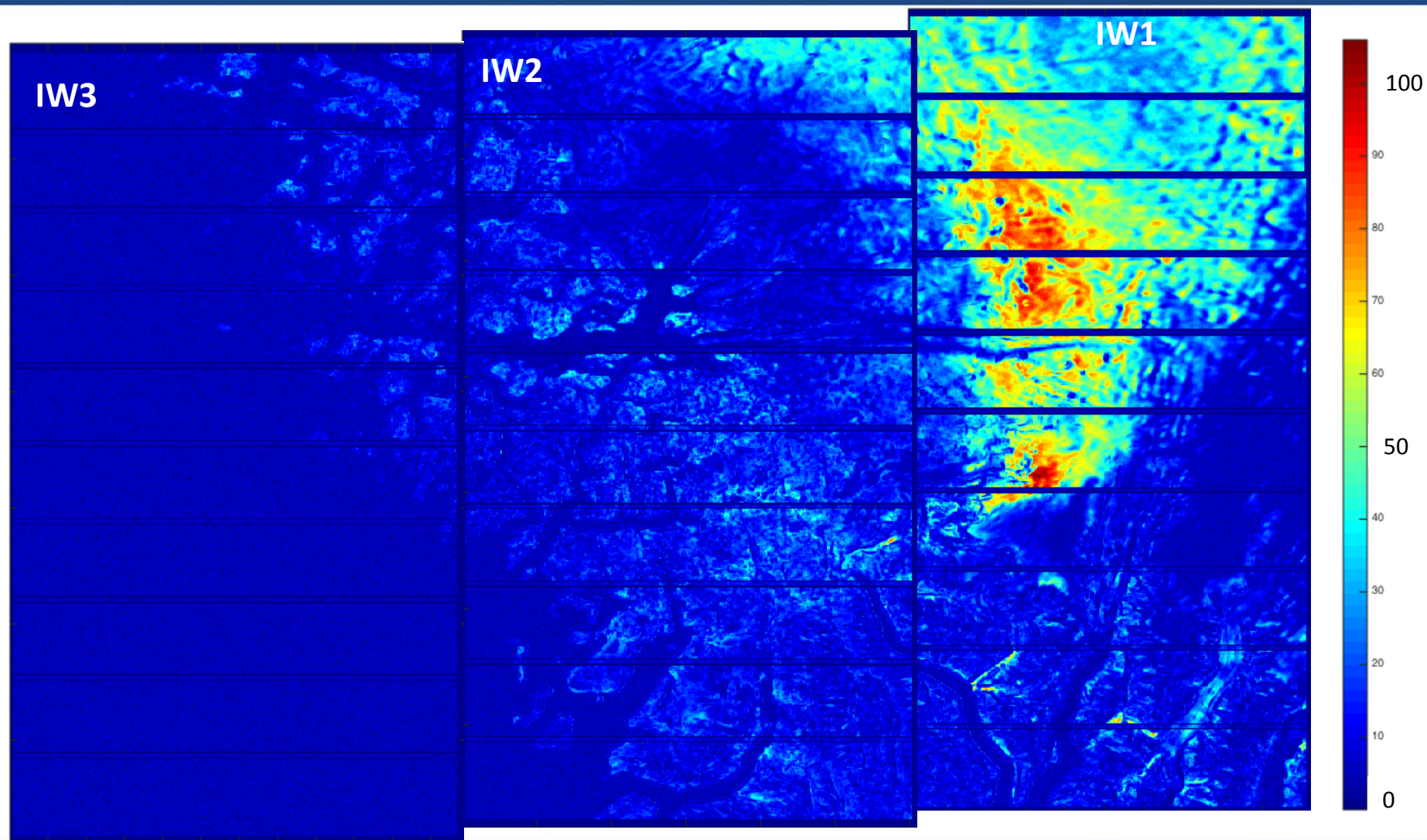
Results: azimuth displacement



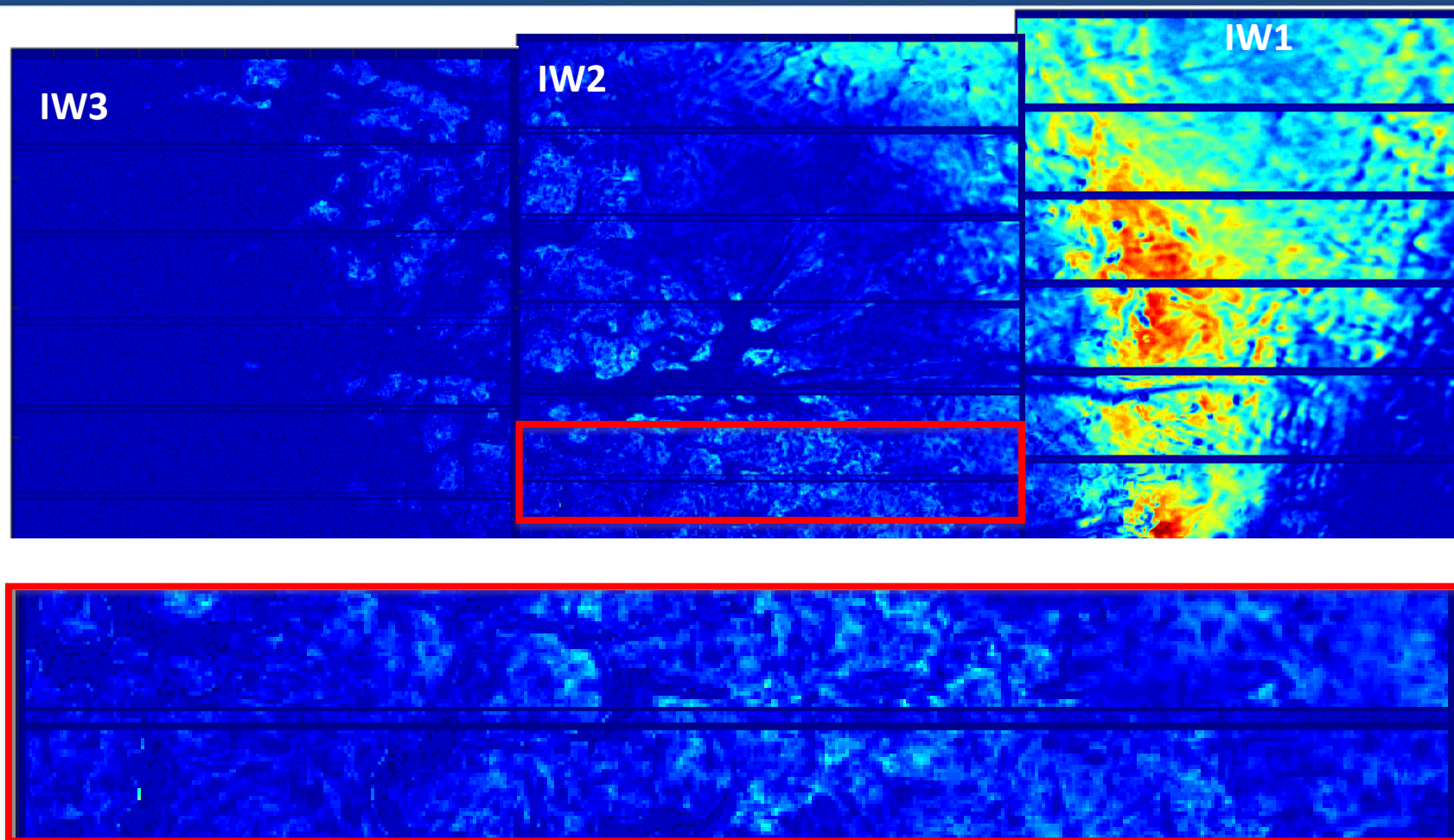
IW1



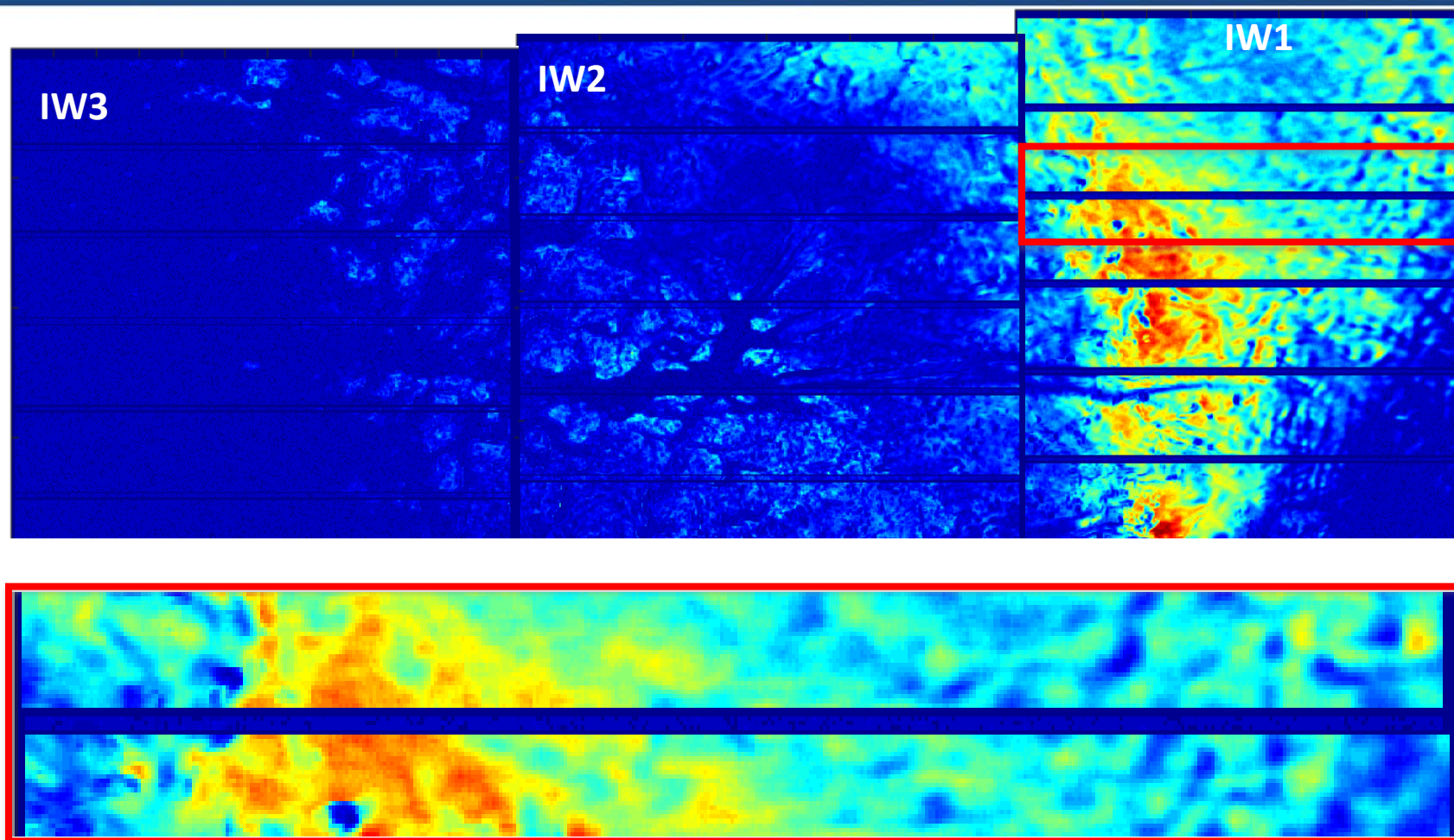
Results: SNR



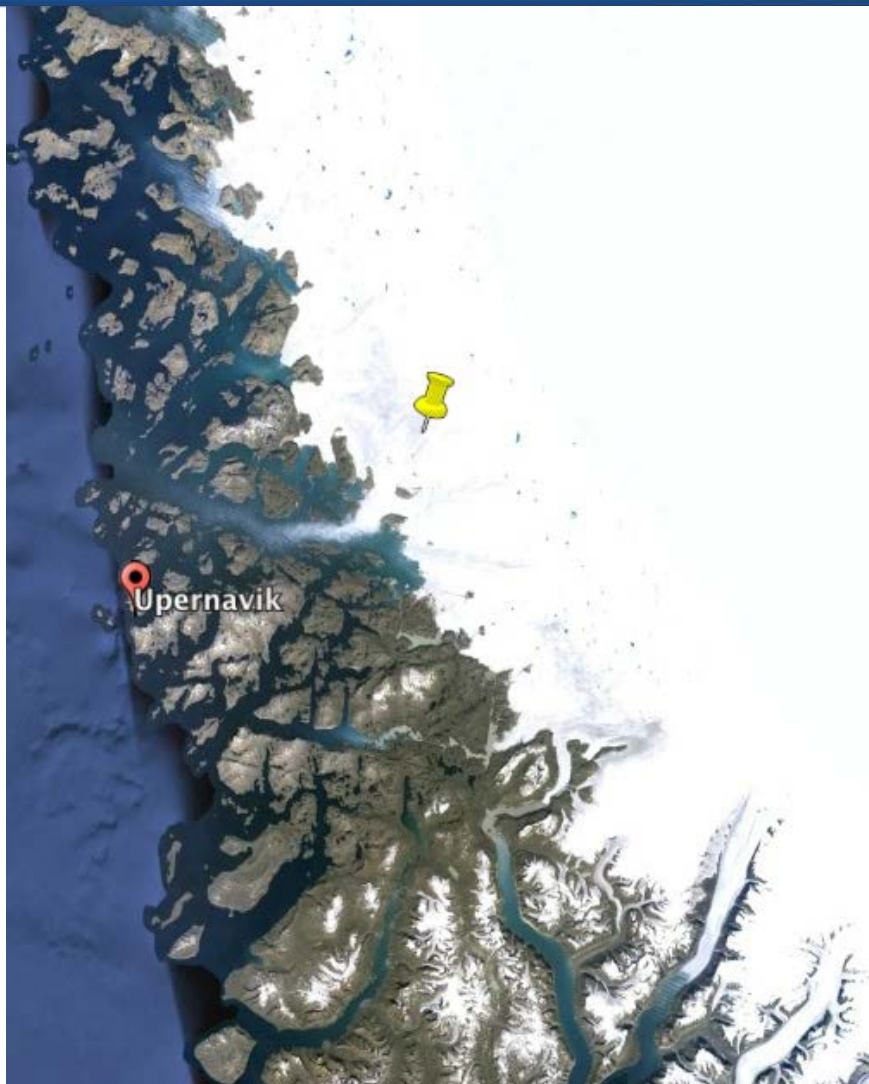
Results: SNR



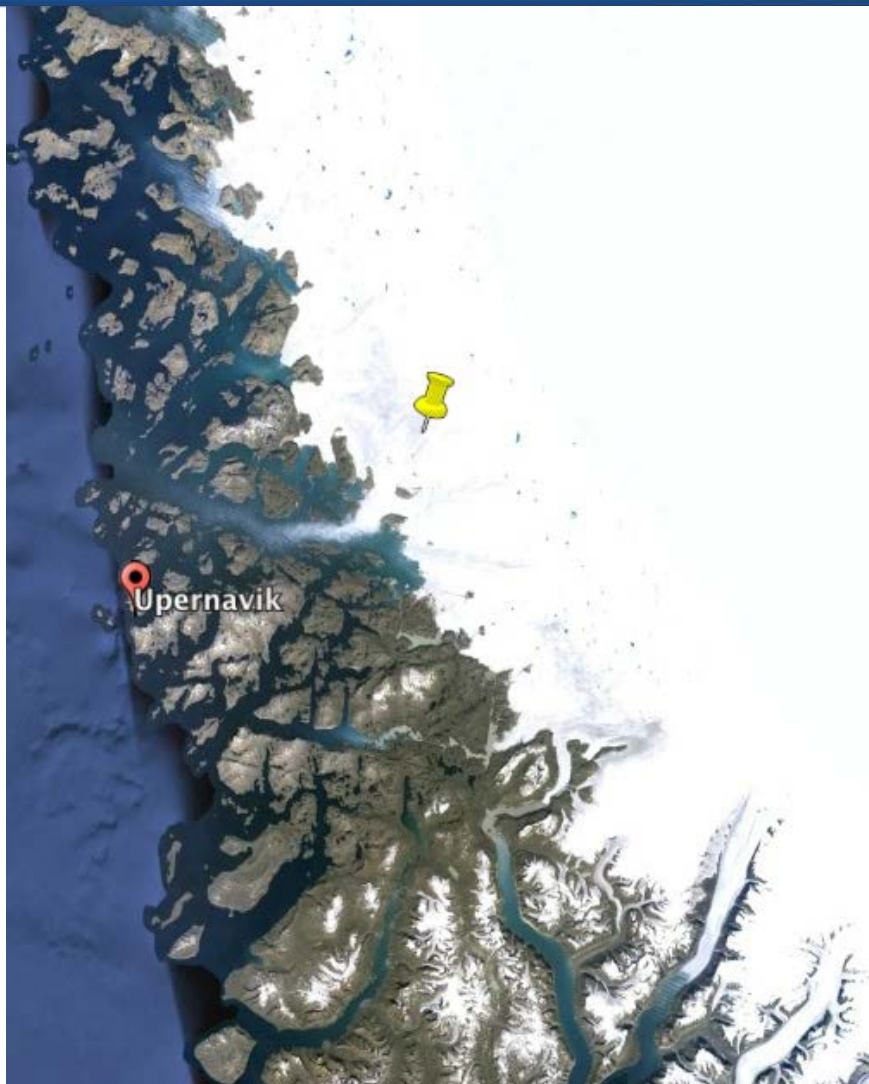
Results: SNR



Landsat imagery



Landsat imagery



Landsat imagery



- Velocity map successfully generated from Sentinel-1 IW SLC data in areas with and without features
- At high elevations, two corresponding (multi-temporal) bursts can be successfully cross-correlated, but two consecutive bursts cannot (presumably due to a lack of ice features)
- At low elevations (where ice features are often abundant) also consecutive (multi-temporal) bursts can often be successfully cross-correlated
- The IW GRD product may be applicable for (gap-free) feature tracking
- The IW SLC product is required for (gap-free) speckle tracking